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Important Economic Issues to Address with Coal-bed Methane

DRAFT

Background

The crucial driver of coal-bed methane (CBM) development in Southeastern Montana is economics. CBM companies have discovered that there is substantial profit to be made from developing methane in the Powder River Basin of Montana and Wyoming. In addition, there is an increasing demand nationwide for cleaner burning energy sources located within our domestic borders.

The job of the Montana Department of Environmental Quality (DEQ) and other state and federal agencies is to ensure that CBM development proceeds in a manner that does not cause significant environmental damage or violate any laws. Part of that process involves writing an Environmental Impact Statement (EIS) to study the potential impacts of large projects like CBM. Within this EIS is a Socio-economics section that examines the potential social and economic effects of CBM in Montana. The U.S. Bureau of Land Management (BLM) and Montana DEQ are co-leads on the Environmental Impact Statement (EIS) for CBM development in Montana. This document has not yet been released as of October, 2002.

As an economist at DEQ, I have written this draft paper in order to stimulate a discussion of whether or not coal-bed methane (CBM) development is socially and economically beneficial overall to Montana and its inhabitants.[1] This draft paper does not give a definitive opinion on CBM development, but instead identifies important economic issues surrounding CBM. This paper is not an official document within the EIS process or any other regulation of CBM. Instead, it contains my thoughts on important issues that should be considered for a complete and comprehensive look at CBM economics.

This paper outlines a general economic framework for estimating the effects from CBM development in the Powder River Basin (PRB) area of Southeastern Montana.[2] The framework consists of a benefit-cost analysis that is designed to evaluate both the favorable and unfavorable effects of methane extraction.

Methodology

Benefit-Cost analysis is the appropriate economic tool to evaluate CBM development in Montana because it will provide the most accurate and complete picture of the effects of methane development on society as a whole. Benefit-cost analysis formally evaluates both the favorable effects (benefits) and the negative consequences (costs) of any given development and determines which is greater. If the total societal benefits of CBM are found to be greater than total costs, one can say that CBM benefits society overall (in our case, society includes the state of Montana). If not, then CBM does not benefit society overall. Benefit-cost analysis can address both the 'internal' effects of CBM borne by the developers (methane companies) and 'external' effects borne by the rest of society who are not a part of the companies involved with the project. Both effects are important if one wants to come up with an accurate picture of a project's total economic effect. For the purpose of the EIS and public interest, however, it is the external societal effects that are of primary importance.

Benefit-cost analysis has other advantages that make it appropriate for looking at CBM development. It has the advantage of allowing one to evaluate different CBM development scenarios (which may vary by number of wells, extraction technique, etc.). Benefit-cost analysis also has the advantage of allowing one to compare and rank different alternative(s) to the proposed CBM development. Benefit-cost analysis can also partially answer the important distributional question of who wins and who loses from a given project. A deeper look at winners and losers, however, would require another tool such as Economic Impact Analysis. For this paper, we will stick with B-C analysis.

The economic framework presented in this paper places special emphasis on quantifying and/or qualifying all significant 'external benefits and costs' involved with CBM development. External benefits are positive economic and social contributions from CBM development that affect the vast majority of society not directly involved with

[1] This is different from asking whether CBM is profitable to companies—we can assume that is the case or they would not be attempting to develop the resource.
[2] In particular, Big Horn, Powder River and Rosebud Counties are the areas of concern for future development. Neighboring counties in Wyoming are currently home to thousands of CBM wells.

methane extraction. Typically, these benefits are taken into account by decision-makers and include things like new jobs, increased income, and new tax revenue. External costs are any adverse effects from CBM development that affect the vast majority of society not directly involved with methane extraction, such as nearby land owners, local governments and ranchers. Such costs are often ignored by policy decision-makers and government regulators, unless explicitly included in an economic analysis.[3] The external costs with CBM may be quite significant and thus must be fully considered to make development decisions that are best for all Montanans. They might include adverse changes in an area's social characteristics and ecology.

Due to the complexity and uncertainty of future CBM development in Montana, it is not known how development will proceed. As a result, a comprehensive economic analysis of CBM may be of most use if <u>it considers several CBM development scenarios</u>. These scenarios might vary in terms of the number of wells drilled in Montana, their location, the extent of Wyoming CBM development, and perhaps most importantly <u>the environmental mitigation techniques used by developers</u>. More will be discussed about multiple scenarios later in this paper.

Important CBM Costs and Benefits to Consider

Determining whether CBM development is beneficial overall to Montana involves analyzing several methane-related issues in the most objective manner possible. This process may involve questioning current beliefs that have attached themselves to CBM. For example, the rapid development desired by industry may not be in the state's best interest. Also, there may be substantial environmental costs to Montana from CBM development that are not necessarily being taken into account. On the other hand, methane is a relatively clean-burning energy that is greatly needed in America as a result of rising energy costs and an increasingly uncertain foreign market.

Benefit cost analysis provides an objective framework for thinking about these and other issues. First, one identifies potential benefits and costs associated with CBM development. That is the easy part. One then attempts to estimate the monetary amount (or magnitude) of each benefit and cost. Once that is done, one can then come up with a sort of 'balance sheet' to weigh total benefits and costs against each other. Finally, one can say something about who the winners and losers are from the project (including things like the environment, social fabric and local schools).

Social Benefits of CBM Development

[3] The potential costs of CBM borne by affected parties (e.g. local residents) and those imposed upon the natural resources of the region (especially water) have not yet been estimated in anything I have seen. The Bureau of Land Management has written several Environmental Impact Statements (EISs) concerning CBM development in the Wyoming portion of the PRB. While these documents briefly describe potential external costs from CBM development, they do not comprehensively address those costs nor do they compare costs and benefits.

Although we are concerned primarily with CBM effects on Montana, we will start to identify benefits on a larger scale. CBM development over its lifetime will provide the benefit of a new source of relatively clean energy to the U.S. as a whole. Assuming a well-functioning, competitive gas market, the beneficial value of this energy will be reflected in the gross revenue made by methane companies from selling the gas. Energy consumers nationwide may benefit from Montana-produced methane in the form of lower energy prices and increased domestic energy reliability, which would be benefits above and beyond that reflected by gross revenues. Worldwide, there would be benefits from lower levels of greenhouse gases being released per unit of energy consumed (since methane burns relatively clean). It is important to note that the small percentage of domestic gas that would come from Montana CBM is probably too small to make much of a noticeable impact on the national gas market, and thus changes in prices and energy reliability from Montana-produced gas are likely to be insignificant at a national level.

A majority of the total revenue earned from the methane itself that goes to the methane companies and a majority of any additional benefits to energy consumers would go to companies and persons who reside outside of Montana.[4] Despite this outward flow of benefits, Montana also stands to reap significant benefits over the lifetime of methane development. These include a significant new source of state and local tax revenue, royalty and lease income which are very important in these times of budget deficit. Benefits to the local area in and near the proposed development potentially include the injection of money into the local economy, a low to moderate number of higher paying jobs to in-state employees, free water to local ranchers, and any environmental benefits that result from the extraction (e.g. creating wetland habitat from CBM ponds).

Out of the benefits mentioned above, CBM tax and royalty revenues at a state level may be the most significant benefit to Montana. This revenue paid by CBM companies to the state could amount to approximately $442 million over 20 or more years according to one industry estimate (David Heinz, CMS Energy). Spread out over 20 years, this is a small but significant percentage of Montana's total annual revenue collection.[5]

A few private landowners who own the mineral rights to their land would also gain significant royalty revenues from CBM development over its lifetime if they choose to allow extractors on their land. It should be noted, however, that only a very small percentage of landowners own the mineral rights to their land. The federal government would also gain royalties on development on federal lands, which would again flow out of state. Some private landowners without mineral rights would gain a modest fee for surface land disturbance if they allowed development on their land, but this would not likely be substantial.

Montana inhabitants who live close to or in the proposed development area also stand to gain from increased income as a result of potentially higher paying jobs from CBM.

[4] Most methane companies interested in development with Montana appear to be from out-of-state.

[5] If the average annual state tax revenue from CBM is about $22 million and total average annual Montana tax revenues are around $1.5 billion (in 1998), then CBM would constitute about a 1.5% overall increase in tax revenue during the life of the project.

Increased income may include jobs to those who were previously unemployed. The number of those jobs that go to Montanans, however, would likely be small (perhaps in the low hundreds) and most white collar jobs would go to out-of-state employees. Some ranchers may gain free and abundant water from CBM operators (that lasts the duration of development) who set up watering systems for that purpose. Such water might also help some wildlife during the development period.

Social Costs of CBM Development

CBM development over its lifetime could result in costs that potentially include environmental degradation, adverse economic effects to farmers and ranchers, social division and the expected economic consequences from short-term, boom and bust extraction development. The extent of environmental degradation from CBM would depend upon the extent of methane development, upon actions taken by environmental regulators and upon the mitigation techniques used by industry. The most significant environmental costs would likely involve changes in surface water quality, changes in soil quality, groundwater draw down, adverse effects to current water users, surface disturbance, erosion, and effects to wildlife. The most identifiable environmental costs would be those where the current use of a potentially disturbed resource such as water or soil can be approximated with a monetary value such as on irrigated crops or the cost of digging deeper water wells.

Social costs would include changes in lifestyle and the rural character of the area, changes in employment patterns, psychological stress, community stress and additional expenditures required by local government for extra roads, schools, housing etc. for methane workers/operations. Finally, there may be devastating economic consequences when the short-term monetary injection into the local economy by CBM inevitably ends. The evidence for this is from previous 'boom and bust' cycles in Montana.

Environmental costs could be complex and widespread. Grazing and a small amount of irrigated agriculture are currently the major uses of land and water in the Powder River Basin where most CBM development is initially expected.[6] The major uses of groundwater in the Basin are stock watering and municipal and residential wells. CBM development would take that same groundwater and bring large amounts of it up to the surface unless some type of re-injection occurred. It is important to note that many people feel such water is priceless due to the scarcity of surface water in the region, so there is certain a cost of using that groundwater now for methane extraction vs. using it later for another use (this is often referred to as an 'opportunity cost' by economists).

[6] I have identified county-wide values for both cattle and agriculture in both Big Horn and Powder River counties with the understanding that any effects upon these from CBM would only involve a small fraction of the values. Such county-wide values are used for reference points more that anything. The figures are derived from the National Agricultural Statistics Service (NASS) Webpage at: http://www.nass.usda.gov/mt/. These values include the amount of land used for both agricultural and grazing purposes in each county, average grazing rates and prices for various crops and for cattle.

Discharged groundwater from methane wells comes from deep underground and has elevated levels of constituents such as salts (chlorides and sulfates), and metals (arsenic, boron, mercury, lead, sodium, iron). High levels of salts and metals can have detrimental effects on aquatic and fish life if discharged directly into state waters when streamflow volumes are not sufficient to adequately dilute the constituents.[7] Also, the same state waters that would accept high levels of salts and metals are used to irrigate crops. Some crops have a low tolerance to salinity levels in the water and could be adversely affected by discharges. Furthermore, a draw down of groundwater in any given area could dry up residential wells and wells used to water livestock. Also, increased water flow through streams and gullies from discharges could result in the increased erosion of land surfaces and damage to riparian vegetation.

Identifying the Benefits and Costs of CBM development and the Challenge of Estimating Monetary Amounts

In a separate draft document entitled "Potential Benefits and Costs to Montanans of Coalbed Methane Development in Montana", I have compiled a comprehensive list of potential benefits and costs from CBM development into one table. I have also compiled a *partial* list of benefits and costs in this paper on the following pages, in order to give the reader some idea of the data and effort that would be needed to conduct a comprehensive benefit-cost analysis of CBM development.

While the items identified in these tables are fairly easy to identify, they present great challenges in terms of monetary quantification. In the separate document "Potential Benefits and Costs to Montanans of Coalbed Methane Development in Montana", I speculate how important (the magnitude) each identified benefits and costs might be, but do not attempt to put monetary values on them. In Table 1 in this paper, I simply list possible benefits and costs and what data might be needed to estimate them. Clearly, a concerted research effort would be needed to come up with defensible values for each.

Monetary quantification of costs and benefit is very challenging for several reasons. For one, the significance of any given impact depends upon the present quality of the affected natural resource and on its present and potential future use. For example, the potential of discharged CBM water to harm irrigated crops will depend upon the type and amount of crop currently grown, the price the crop is selling for, the current water quality in the river, the current irrigation technique and the total concentration of soluble salts and relative proportion of sodium to other cations in the discharge water (e.g. calcium, magnesium and sodium). These all vary from site to site and take a lot of effort to collect. Also, some of the identified benefits and costs likely are not significant. For example, there is not a lot of recreation in the Powder River Basin aside from hunting on private land and fishing in the Tongue River Reservoir nor is the disturbance of historical sites likely to be a major problem from CBM. Another challenge of quantification is that Montana water quality laws are supposed to protect all beneficial uses of water so it is unclear how much development will be allowed anyway. Also, certain mitigation

[7] Of great concern to DEQ are the effects from CBM on the quality of affected state waters.

techniques such as holding ponds could allow much more development than if discharge water is dumped directly into the river.

Perhaps the greatest challenge with respect to quantifying CBM benefits and costs is that some costs and benefits cannot easily be measured in dollar amounts, even if we conceptually know what outcomes to expect. It would be very hard, for example, to put a monetary value on disturbance of non-game wildlife and riparian vegetation from CBM. It would be just as challenging to estimate the value of depleted groundwater to future generations (which is a crucial long-term issue) because we do not know how that depletion will effect area residents and because people put different values on groundwater in the Basin (some feel it is priceless). To partially overcome this problem, ranges of values could be used for effects that are hard to quantify (such as changes in irrigation water quality) or perhaps numbers from other studies (that have estimated similar values in different geographical areas) could be used as well. Regardless, all potential costs should at least be mentioned qualitatively in the EIS or other pertinent documents.

Finally, it is important to remember that some of these costs and benefits will occur only in the short term and that some could be permanent. Some effects will not last for long because they should be eventually mitigated by natural restoration (e.g. surface water quality) and reclamation done by the CBM company (e.g. restoring vegetation in certain areas). On the other hand, land downstream from a holding pond could become permanently impaired from salinization or permanent erosion could take place. These are all issues to discuss with others working on this CBM issue.

Let us now list potential social benefits and costs.

Potential societal benefits from CBM development over its lifetime include the following: 1) Increased wage income and employment to residents of Montana from methane-related jobs, 2) Positive secondary economic effects on the local economy from CBM development, 3) Tax revenues to the state from methane-related natural resource, corporation, property and income taxes, 4) Royalty income to private landowners and the state, 5) Any other contributions to local communities by CBM companies such as free water to ranchers or 'good will'/legally required donations to local community, on a national scale 6) Economic and reliability benefits to energy consumers from the methane extracted (above and beyond the financial value of the methane), and on a larger world scale, 7) less greenhouse gases per energy unit consumed (compared with other fuels) from using this cleaner methane energy source.

Table 1 below lists three of these potential external benefits from methane development—additional income, additional tax revenue and the benefit of the gas itself. The table **qualifies** (identifies) each of these potential external benefits from CBM. It then indicates whether a particular effect can be quantified in monetary terms or simply qualified. It would probably be feasible, for example, to estimate the CBM tax revenue benefits to Montana in dollar amounts, but would be very difficult to estimate the monetary benefits of burning a cleaner fuel. Finally, data requirements are listed for each benefit. A similar table is found in the next section for external costs. For simplicity, not all potential benefits or costs are included. The purpose of Table 1 is not to be all-inclusive but to give an example of what would be involved in estimating select benefits and costs from CBM development. A comprehensive looks at all benefit and costs is included in the document entitled “Potential Benefits and Costs to Montanans of Coalbed Methane Development in Montana”.

Table 1: Potential Societal Benefits from Coal Bed Methane

Benefit from:	Benefit in the form of:	Quanit-fiable?	Data Requirements
Tax Revenue	Increased tax revenue from CBM development	Yes	Tax rates and estimated total revenue from methane
More income to Montana workers	More income for workers and jobs for those currently unemployed	Yes Yes	Estimate number and duration of jobs created, the current mean income in the area and the unemployment
	Increased economic activity from CBM	Yes	Estimate total increase in income and a multiplier rate
Methane itself	Lower energy prices?	Yes	Doubtful that this will happen
	Improved U.S. balance of trade	Maybe	Important, but doesn't directly affect Montana
	Less GHG emissions	Maybe	Again, this is a world issue-

Potential social costs from CBM include the following: 1) Environmental degradation from methane extraction and its impact on the local economy, 2) Social costs from CBM such as changes in lifestyles and employment patterns and psychological effects upon communities, 3) Adverse economic effects from the traditional cycle of boom and bust extraction economies, 4) Increased spending by local government for supporting infrastructure such as increased road repair, and 5) decreased property values. Some of these external costs would likely be offset by other benefits. For example, any increased spending by local government would likely be at least offset by increased tax revenues from development. Environmental degradation costs could be offset by increase mitigation by CBM companies. <u>It is also very important to note some of these costs could extent far into the future well beyond the lifetime of methane extraction.</u>

The most significant environmental costs of CBM would likely involve changes in water quality, changes in soil quality, groundwater draw down, surface disturbance, and effects to wildlife. Each of these could have monetary costs associated with them. There would also be some aesthetic costs from the sight of gas drills, heavy trucks, bulldozers, new roads, piles of pipes, ditches to accommodate them, and reservoirs freshly dug to hold some of the water pumped out in the mining process. There may also be problems with flooding from groundwater and unnaturally created bogs, wetlands, etc. These costs and their data needs are more specifically discussed in Table 2 below.

Social costs might include changes in area lifestyle, divisions in communities and landowner stress (both of which are already happening) and a shift of labor away from low paying agricultural jobs. The boom and bust cycles of short-term resource extraction have often left communities in shambles (and with environmental problems) after development leaves, which could be a cost. Also, communities may have to provide for more schooling and housing to support incoming workers which could raise the tax base.

Table 2 below lists some of the potential external costs from methane development. It has the same format as Table 1, and does not include every potential cost. It is important to remember that some costs like degraded farmland may not happen because Montana water quality laws would prevent such a case. Still, it is valuable to list such costs.

Table 2: Potential Societal Costs from Coal Bed Methane

Resource of Concern	CBM Effects on Resource	Economic Effect	Quant-ifiable?	Data Requirements
Social capital	Divide towns	not sure-social stress	Maybe	??
	Displace jobs	depress agriculture	Yes	employment patterns before and after CBM
Local economy	Boom & bust	Devestate local econ.	maybe	Previous case studies
Public services	More needed for CBM	More local spending needed	Yes	Estimate costs for more: schooling, roads, firemen
Environmental Costs				
Agriculture and Cropland	Poor quality irrigation water and lost cropland	Lower crop output from bad irrig water	Yes or maybe	Crops affected, % crop lost, acres lost, crop value
		Permanent lost crop-land from soil salinity	Yes or maybe	Acres Affected, acres lost, value of cropland
Livestock	Groundwater Drawdown	Need to re-set stock wells or find alt water	Yes	Number of wells, Extent of drawdown, Effect on wells
	Soil erosion	Lost grazing land	Maybe	Talks with ranchers
	Vegetation loss	Lower production	Maybe	Talks with ranchers
	More dust	Loss in cattle weight	Difficult	Talks with ranchers
Residential, municip wells	Groundwater Drawdown	Wells drying up/ higher pumping cost	Maybe	Extent of drawdown, # of resid & muni wells affectd
Habitat	Fragmentation	Erosion of soil	Difficult	Potential acres
		Disturb. of vegetation	Difficult	Potential AUM
		Disturb. of riparian	Difficult	Potential AUM,
		Disturb. Of wildlife	Difficult	Wildife Inventory
Human Disturb.	Noise, air pollution, floods,	Disturb. Of residence	Maybe	Property values
		Visual pollution	Difficult	Past Studies

Identifying Internal Benefits and Costs

Although we are not really interested in the benefits and costs to the methane companies, a complete benefit-cost analysis of CBM would consider both the industry's private, internal benefits and costs, and society's, external benefits and costs. Again, it is the latter that is really of interest to the public and residents of the local area.

Internal benefits and costs of coal-bed methane consist of the net benefits that accrue to the companies (developers) from extracting and selling the resource. At a basic level, the net benefit or earnings to a methane company equals the total gross revenues from methane extraction minus the total costs. Revenues are the money the company earns from selling the methane gas. Total costs to developers include wages to labor, capital investment, financing, insurance, depreciation, taxes and royalties, and environmental quality mitigation measures. These costs can be quite high.[8] While the net benefit for any project can be a negative number and often is in today's business climate, it is assumed that CBM developers currently expect positive net benefits or else they would not develop the resource. This information is often proprietary, so it is not possible to know what profit companies expect to make, and thus is not possible in this paper to even guess at what the internal benefits and costs from CBM might be.

It is important to note that when wellhead natural gas prices are at high levels, the pressure to develop is greater (since revenues and earnings will increase) and when gas prices are lower, that pressure tends to ease off. The number of wells operating at any given time will be affected by these prices. It may be the case, based upon the history of CBM in the U.S., that CBM companies stand to earn the most profit when they develop the resource as rapidly as possible (perhaps to minimize risk or develop the gas before someone else retrieves it).

Quantifying CBM costs and benefits

Estimating how large CBM costs and benefits might be to Montana is an important step in the process of economic analysis. To illustrate this, coalbed methane could raise billions in revenue for the methane companies (and U.S. economy) and create tax revenue to the state of Montana in the hundreds of millions. Meanwhile, agriculture and ranching in the area produce annual sales in the tens of millions and will likely produce sales in the high hundred millions to low billions over the 20 year CBM development period. Only a portion of that agricultural income is irrigated, and it is not known how much of the irrigated crop land would be affected, if any, by CBM. So, in a comprehensive economic analysis, one is balancing a lot of potential tax revenue for Montana (which is budget-strapped) with a potential for harming local agriculture and disturbing the local ecology (perhaps for the long term) and it is important to get a big picture of the money values we are talking about. It is also important to note that the area of concern is sparsely populated, and does not comprise a significant portion of Montana's economy, whereas the methane may be used by many people. These example

[8] For example, I have heard repeatedly that the wellhead price of methane would have to be near $3.00/Mcf just to break even.

of ‘big picture’ thinking help one get a grasp on the magnitudes of effects that could occur.

Estimating the magnitudes or monetary values for the benefits and costs of CBM is obviously an important component of economic analysis and a challenging one as well. So, after identifying potential CBM costs and benefits, the next step in a comprehensive economic study would be to estimate monetary values for each to the extent possible. If a monetary amount cannot be estimated, there should at least be some idea of a magnitude and potential effect.

Here as an example of looking at the potential for harming irrigated cropland. Big Horn County made $65 million in receipts off of livestock and $25 million off of agriculture in 1999 (This crop data found at http://www.nass.usda.gov/mt/ in conjunction with the Montana Agricultural Statistical Service). Also, Big Horn County currently has 2,400 residential water wells upon which 2,300 people rely (Montana Department of Commerce). These wells have the value to residents of providing their water needs. In money terms, this value is at least the cost of the electricity to run them and investment to build them. These numbers demonstrate the economic importance of several potentially affected resources in a county where CBM is proposed. They do not represent damage done by CBM by any means, but simply what the resources are approximately worth on a money scale in their present condition. This is a starting point for estimating difficult numbers like the damage to homeowners whose wells run dry.

For estimating the potential costs of CBM development on crops, the expected effect of CBM on water quality, if any, could be simulated for a given state water body (assuming a given number of methane wells, the content of well water and the average discharge per well). Once the water quality effects were simulated (assuming there was an effect), the resulting effects could be predicted on each crop irrigated by that water. Any lost revenues from loss or damage of crops as a result of changes in the water quality could be used as a cost. Prof. Jim Bauder at MSU has actually done work in this area modeling the expected effects on crops from different levels of water quality in the Tongue River. Such a modeling technique could be quite complicated and involved.[9] Estimates could also be made of the costs/effects from switching some irrigated land over to non-irrigated land if that were to occur as a result of CBM discharge water. In addition, if farmers were forced to obtain irrigation water from elsewhere, any price differential in that new water could be used as a cost. These would be different methods of estimating a difficult number.

Another possibility for estimation would be to use the value of foregone irrigation water as a proxy for CBM cost if the Tongue River was no longer suitable for some or all crops (although the law should not allow a lose of beneficial use). This could be done by attaining an estimate for the value of one acre-foot of water for irrigation and multiplying that number by total expected acre-feet of water displaced. The point with this example

[9] To simulate the effects of CBM on irrigated crops, for example, one would have to consider the specific watersheds, crop species, soil types, irrigation techniques, irrigation amounts, well locations, mixing zones, water temperatures and pH, etc.

is that there are many options one might pursue to estimate hard-to-get monetary numbers. Let us look at another example of cost estimation.

To estimate the potential costs of CBM on cattle and residential wells would require some idea of the extent that groundwater would be drawn-down from CBM and how this might affect wells in the area. One would determine the number of wells used to provide stock water and the number for residential use. The next step would be to then predict roughly how many of these wells would be affected from water draw down. Once done, calculating the costs of re-setting those wells or finding alternative water sources might be fairly straightforward. These costs might serve as a good proxy for the value of that water. Other costs and benefits would follow a similar analytical pattern for their estimation.

Major Issues That May Affect Economic Analysis

It was mentioned in the introduction that this analysis would be most useful if it presented the costs and benefits of several development scenarios. The reason for this is that there are several major factors that could greatly affect any economic analysis concerning CBM. Doing so would help fulfill the EIS criteria that other development alternatives (aside the proposed development option) must be considered. . Benefit-cost analysis would be done on each of these scenarios and might produce very different results for each. In this way, several alternatives could be compared with each other as is required in an EIS. Each scenario/alternative would include <u>all</u> benefits and costs of the development in order to be economically sound. Those benefits and costs that cannot be quantified would still be discussed and some magnitude estimated.

The following factors will most likely affect the economic analysis:

Distributional Analysis-Winners and Losers

Not only is it important to compare benefits and costs of development (or of alternate development scenarios), but it is also important to identify winners and losers. Anyone in Montana who realizes a net gain from CBM development such as a worker from Montana or recipient of royalties is a winner. A farmer that loses land productivity without any compensation would be a loser from the project. A city that receives extra tax revenue from CBM but also incurs extra costs on services, may be a net winner or loser, and the same goes for the rancher who loses water wells but gains free water.

At this point, one can say that those involved with CBM (including workers) are expected to gain from the development. It is much harder to say what will happen to those that live in the local area. With water and lifestyle viewed as priceless by many in the area (from the EIS scoping meetings), it may be hard for any compensation to offset the losses.

Extent of Development That Occurs in Montana and Wyoming

Obviously, the benefits and costs to Montana of coal-bed methane will depend upon how extensive methane development is. This will depend upon factors like wellhead price and consumer demand for the gas. The greater methane development is, the greater both the benefits and costs of development are likely to be for Montana. For example, 18,000 wells in Montana vs. 5,000 would likely result in more company profits and more tax revenues to Montana, but could also result in greater environmental and social costs to the area. Thus, it is hard to say how the scale of development will affect net benefit.

When thinking about the extent of methane development, one must consider both Montana and Wyoming. Wyoming is a factor because any development along the Power, Little Powder and Tongue Rivers in Wyoming will affect downstream water quality in Montana and thus present potential costs to Montanans. It may also preclude development in Montana due to water quality constraints. Thus, different scenarios might include certain combinations of numbers of wells in each state.

Economic conditions will determine the push for development and influence whether it will be extensive in both states if developers have their way. Even marginal wells would likely be drilled if prices were high enough and the needed infrastructure (e.g. power lines, pipelines) installed. However, water quality laws could certainly limit development or dictate certain water disposal methods. Total development within each watershed will be limited by the capacity to treat or contain discharge water and by water quality standards that limit different pollutants in those rivers.

It is important to note that the Powder River is already impaired and thus must experience an improvement in water quality, which could severely limit development on the drainages of those two rivers. The Tongue River is better than standards, so some degradation could be allowed, if it can be proven that CBM constitutes important economic development. There are clearly lots of options to deal with here.

CBM developers themselves have several options faced with such standards. One is that they can simply build less wells which will discharge less water into the rivers. This would result in less development and lower profits. The other is that they could spend more money per well treating the discharged groundwater or re-injecting it before it reaches the streams. Considering the higher prices of natural gas, this second option seems very feasible.

Speed of Development in Montana

Extracting methane on the quick schedule desired by methane companies may be economically inefficient. Several alternatives for extracting and using methane have been discussed among interested parties including piping it directly out-of-state, on-site electrical generation and fuel cells. There may be ways to use methane in such a way that extraction and usage could be done more efficiently and have a long development life. The longer the development life of CBM, the more likely Montana and locals will experience benefits. The same, however, could be said for costs. Longer development may also decrease industry profits and thus decrease internal net benefits. All options should be at least considered.

Mitigation Techniques Followed by Methane Companies

If developers decide to treat their water to a greater extent than just dumping it into state waters, then the scoietal environmental costs of degraded water from CBM would decrease. The amount of cost decrease would depend upon the treatment technique (e.g. ponds, reverse osmosis, ion exchange, etc.). If they re-injected the water back underground, likely the most expensive method of treatment, then environmental costs from CBM could greatly decrease.

Different development scenarios could include different mitigation techniques by methane extractors. One might include, for example, the current situation with water going into state waters and into impoundment ponds. Another scenario might include re-injection of at least some water. In each scenario, we might say how much each mitigation techniques costs per MCF of methane. This would allow the fascinating analysis of what mitigation technique gives developers the best net benefit and whether or not this same technique gives society the best net benefit. Indeed, while more expensive treatment will increase methane company's internal costs, it may allow those companies to build more wells and actually come out ahead in total profit.